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Supervisor Expression of Interest
MSCA - Marie Sklodowska Curie Action - (PF) Postdoctoral Fellowship 2024

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https://www4.ceda.polimi.it/manifesti/manifesti/controller/ricerche/RicercaPerDocentiPublic.do?EVN_PRODOTTI=evento&lang=IT&k_doc=260438&aa=2023&n_docente=albisetti&tab_ricerca=1&jaf_currentWFID=main

Department Name: Dipartimento di Fisica

Research topic:

MSCA-PF Research Area Panels:

- ☐ ECO_Economic Sciences
- ☐ ENG_Information Science and Engineering
- ☐ ENV_Environmental and Geosciences
- ☐ LIF_Life Sciences
- ☐ MAT_Mathematics
- X PHY_Physics
- ☐ SOC_Social Sciences and Humanities
- ☐ CHE_Chemistry

Brief description of the Department and Research Group (including URL if applicable):

The "Engineering Physics in Nanostructured Materials and Devices – PhyND" group is part of the Department of Physics of Politecnico di Milano, and is located at PoliFab, the micro-nanofabrication center of PoliMi. We develop and use advanced methodologies for tailoring the physical properties of condensed matter systems, with precision down to the nanoscopic scale. Our research aims to realize and study new artificial nanostructured materials and devices where to harness complex phenomena and give rise to enhanced functionalities.
We are funded by several national and EU sources, such as ERC Starting Grant (B3YOND), MUR, Fondazione Cariplo, Eurostars.

The group currently comprises 2 Associate Professor, 2 PostDoc, 5 PhD. Students and 2 Master students.

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TITLE of the project:
Tailoring multiferroicity at the nanoscale in functional oxides via phase nanoengineering

Brief project description:

Introduction

Multiferroic materials, which simultaneously exhibit more than one ferroic order parameter (e.g., ferroelectricity, ferromagnetism), have garnered immense attention due to their potential in next-generation multifunctional devices. Controlling the coupling between these order parameters in thin film oxides is of crucial importance for both fundamental science and applications, yet it is extremely challenging. This proposal introduces an innovative approach: leveraging the direct modification of the properties of materials via phase nanoengineering [1], to manipulate multiferroic oxides at the nanoscale, thereby achieving unprecedented control over their ferroic properties.

Objectives and Methodology

Our goal is to develop and use advanced nanofabrication techniques, such as thermal scanning probe lithography (tSPL)[2–4] and direct laser writing (DLW), to tailor the ferroelectric and magnetic properties of multiferroic oxides with nanometric precision. tSPL and DLW allows to deliver highly localized heat to the surface of a thin film sample, with spatial resolution down to sub-10 nm and a high degree of tunability. Such nanoscale heat produces sizeable, tunable and stable changes in the structural, magnetic and electronic properties of the materials. This process, known as phase nanoengineering, will allow for the spatial modulation of multiferroic behavior, enabling the creation of nanostructures with customizable ferroic orders. By employing advanced complementary characterization tools such as scanning probe microscopy, transport measurements, Raman microscopy, Magneto-optical Kerr Effect, we aim to correlate and study the relationship between nanostructure and multiferroic properties. This will lead to the emergence of new properties in the nanostructured oxides to be exploited for the design of nanoelectronic and spintronic devices that leverage the unique capabilities of multiferroics.
Through the manipulation of multiferroic oxides at the nanoscale, this research aims to develop a new methodology for nanostructuring functional multiferroic oxides, realizing novel multiferroic nanostructured materials. By advancing our ability to control ferroic properties with nanometric precision, we will open the way to the development of a new class of multifunctional nanonadevices.

References

1. Levati, V. et al. Phase Nanoengineering via Thermal Scanning Probe Lithography and Direct Laser Writing. Advanced Materials Technologies, 2300166 (2023).
2. Albisetti, E. et al. Thermal scanning probe lithography. Nat Rev Methods Primers 2, 32 (2022).
3. Albisetti, E. et al. Nanopatterning reconfigurable magnetic landscapes via thermally assisted scanning probe lithography. Nature Nanotech 11, 545–551 (2016).
4. Zheng, X. et al. Patterning metal contacts on monolayer MoS2 with vanishing Schottky barriers using thermal nanolithography. Nat Electron 2, 17–25 (2019).